Phosphor User's Guide
Audio Damage, Inc.
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Introduction

Phosphor is a polyphonic software synthesizer plug-in modeled on the alphaSyntauri hardware synthesizer. Introduced in 1979, the alphaSyntauri used an Apple][microcomputer as its central processor and user interface. While quite modest by contemporary standards, the alphaSyntauri can create a surprising wealth of sounds easily, thanks to its simple but flexible approach to synthesis.

Rather than mimicking the small number of wave shapes available from the oscillators found in analog synthesizers, the alphaSyntauri's oscillators used tables of numbers—essentially samples of a single cycle of an audio wave. The tables are filled with a process known as *additive synthesis*. The basic idea of additive synthesis is that any sound wave can be created by adding together a large number of sine waves of different frequencies. Each sine wave has a pure sound with no harmonics, but if you add a bunch of them together you can create complex sounds. If you use enough sine waves, and if you control their relative loudness precisely over the duration of a note, you can recreate just about any sound.[1]

Since the alphaSyntauri was limited by the computational power available in its day, it took a relatively simple approach to additive synthesis. Each oscillator's wave shape was created by adding together 16 sine waves, which we'll henceforth refer to as *partials*. The wave shape could not change over the duration of a note, but each oscillator's overall loudness was controlled by a separate envelope generator, and hence the timbre of the note could be varied by mixing the two oscillators dynamically. Phosphor reproduces this system faithfully and adds a couple of tricks of its own.

Phosphor harkens back to a time when high-quality digital synthesis was available only to people with huge budgets or access to academic research facilities, but low-quality digital synthesis was finding its way into the public ear through quarter-munching video games and 8-bit home computers. We hope you enjoy using it as much as we enjoyed building it.

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[1] For an in-depth explanation of how this works, see http://en.wikipedia.org/wiki/Additive_synthesis

New in Version 2.0

Version 2.0 of Phosphor adds several features and enhancements to its predecessor:

- More partial sliders, for a choice of 16, 32, or 64 per oscillator
- Commands for initializing the oscillators with common synthesizer waveforms
- A selection of presets from the previous version, some all-new presets to take advantage of the new features, and a selection of Designer presets from Ken Flux Pierce
- A new user interface, appropriate to contemporary display technologies
- VST 3 and AAX compatibility
- A cross-platform XML-based preset file system
- Built with up-to-date code libraries for better host compatibility and future-proofing

Phosphor 2 has a different name and internal identifier than version 1. This means that you can install Phosphor 2 alongside whatever version you are currently using, and continue to use the older version in your existing projects. Version 2 cannot be directly substituted in existing projects and cannot read preset files created by version 1.

Also, direct MIDI control assignment has been removed. Host DAWs have progressed considerably since Phosphor's last major revision and it's now appropriate to leave MIDI mapping up to them.

System Requirements

Phosphor is provided as 32- and 64-bit VST2 and VST3, and 64-bit AAX plug-ins for Windows. On OSX, Phosphor is provided as Universal Binary Audio Unit, VST2, VST3 and AAX plug-ins.

Phosphor is a plug-in, not a standalone application. To use it, you'll need a host application such as Ableton Live, Steinberg Cubase, Apple Logic, Avid ProTools, etc[2]. Obviously you'll also need a computer capable of running one of these applications.

We support the use of Phosphor under Microsoft Windows 8 or newer, and Apple OS X version 10.8 or newer.

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[2] Product names are copyrighted by their respective owners.

Installation

To install Phosphor, double-click the Phosphor Installer icon, and follow the instructions. You can choose which plug-in formats to install and, for some formats, the plug-in destination folder.

To un-install from OS X, simply delete the plug-in from your VST folder, which is usually located at `/Library/Audio/Plug-Ins/VST/Audio Damage`, and your Audio Units folder, which is located at `/Library/Audio/Plug-Ins/Components/`. To un-install from Windows, delete the file named `Phosphor 2.dll` from your VST folder(s). The presets are stored in separate files which you can also delete, although they occupy very little space. On OS X, they're in `/Library/Application Support/Audio Damage` . On Windows, they're in the hidden folder `C:/Program Data/Audio Damage/` .

Operation

The following screen shot shows Phosphor's user interface. Phosphor's controls and operation are described the following text.

1. Wavetable Oscillators

Phosphor's core is a pair of audio oscillators, referred to as the Primary and Secondary Oscillators. Each oscillator has its own wave table and hence its own timbre.
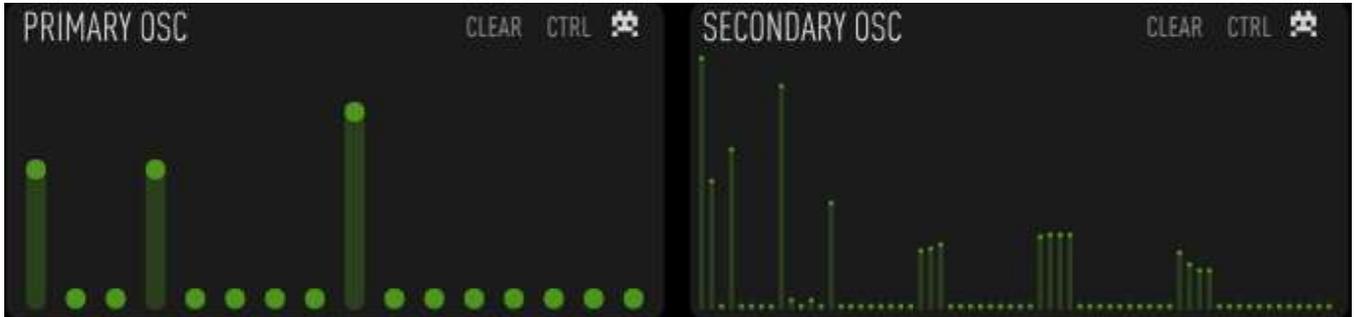
The groups of vertical sliders near the top of Phosphor's windows are called the *partial sliders*. The partial sliders control the level of the partials used to calculate Phosphor's wave tables, and hence control the tone of the oscillators. Each oscillator has its own set of partial sliders which set the relative amplitudes of each of the partials. The left-most slider sets the level of the *fundamental*, that is, the lowest-frequency partial, which has the frequency of the note you're playing. The next slider controls a partial whose frequency is twice that of the fundamental (i.e., one octave above the root pitch). The next slider's partial has a frequency of three times that of the fundamental, and so on.

Each oscillator can have 16, 32, or 64 partial sliders. The alphaSyntauri had only 16 partials; hence version 1 of Phosphor also had 16 partials. Adding more partials adds more higher-frequency components to the sound.

The **CLEAR** and **CTRL** buttons above the partials sliders provide a couple of editing shortcuts. Clicking the **CLEAR** button sets all the sliders to zero. Clicking the **CTRL** button invokes a pop-up menu with several commands:

> 16/32/64 Partials – chooses the number of partial sliders available for the oscillator.
>
> Rand 1/3 - sets all the sliders to zero and then sets about a third of them, chosen at random, to random levels.

Rand Full – sets all the sliders to random levels

Sawtooth – sets the sliders to produce a sawtooth or ramp waveform

Triangle – sets the sliders to produce a triangular waveform

Square – sets the sliders to produce a square waveform

If you turn on the Vintage switch ⊞ above the partials sliders on the right, the quality of Phosphor's oscillators is reduced to resemble the alphaSyntauri's hardware. The Vintage switch introduces aliasing and digital grunge which can add some interesting color to Phosphor's tone.

16 Partials
✓ 32 Partials
64 Partials

Rand 1/3
Rand Full
Sawtooth
Triangle
Square

2. Envelope Generators

Phosphor employs a pair of envelope generators to shape the volume or loudness of each oscillator over the duration of a note. Since Phosphor's oscillators can create entirely different timbres, using the two envelope generators to vary the relative loudness of each oscillator is one of the keys to producing interesting sound with Phosphor.

Phosphor's envelope generators use the traditional "ADSR" design found in numerous hardware and software synthesizers. Unlike most ADSR envelope generators, Phosphor's EGs let you control the curvature of the Attack, Decay, and Release segments of the envelope.

Phosphor's envelope generators have graphical controls that show you the shape of the envelope. Click and drag the white handles to change the envelope parameters as follows:

Decay time and sustain level

Attack time

Release time
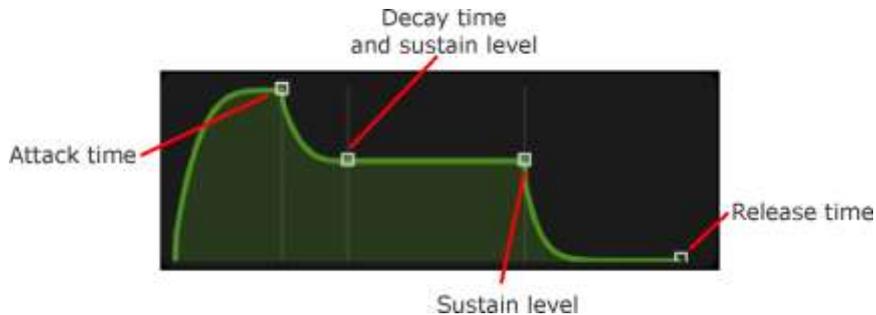
Sustain level

Drag the handles horizontally to change the times; drag the two middle handles vertically to change the sustain level. You can also drag vertically anywhere near the sustain segment to change its level. (The sustain level is the level at which the envelope remains while you hold down a key on your keyboard.)

If you drag vertically between the handles, or to the left of the first handle, you change the curvature of the envelope segment. The alphaSyntauri's envelopes had only linear shape, but Phosphor's adjustable curvature provides a greater variety of envelope shapes.

3. Oscillator Control Sliders

Beneath the envelope generators are groups of sliders which control several parameters for both the oscillators.

Crossmod

The Crossmod sliders enable the Primary and Secondary oscillators to modulate each other's frequency, creating a much wider range of tones than they create individually. While Yamaha made frequency-modulation (FM) synthesis famous with the DX7, Phosphor draws inspiration from the NED Synclavier, which combined wavetable and FM synthesis.

Moving the Primary oscillator's Crossmod slider to the right increases the amount that the Secondary oscillator modulates the Primary oscillator's frequency. This changes the tone produced by the Primary oscillator (and not the Secondary oscillator). In the usual parlance, the Primary oscillator is the *carrier* and the Secondary oscillator is the *modulator*. Generally speaking, as you move the slider to the right, the tone of the Primary oscillator will become brighter and more complex.

It works the other way around for the Secondary oscillator's Crossmod slider: moving it to the right increases the amount that the Primary oscillator modulates the Secondary oscillator, and in this instance, we would say that the Secondary oscillator is the carrier and the Primary oscillator is the modulator. Since both oscillators can modulate each other, we call Phosphor's FM scheme cross-modulation.

The signals used for cross-modulation originate after the envelope generator but before the Level slider (described below). This means two things: first, since the timbre created by frequency modulation changes with the amplitude of the modulating signal, you can use the envelope generator of the modulator to make

the tone of the carrier vary over the duration of the note. Second, you can use the level slider of the modulator to reduce or remove its signal from Phosphor's output so that you hear only the changing tone of the carrier.

Noise

The Noise sliders control the loudness of noise generators whose outputs are mixed together with the signals from the oscillators. The noise generators create white noise—noise with a flat frequency spectrum—and are useful for adding bite to percussive sounds or a bit of grunge to the pure sine waves emanating from the oscillators.

If you click on the VINTAGE switch to the right of the Noise slider, the noise generator reproduces the sound of noise sources found in computer sound generators that were contemporaries of the alphaSyntauri. In this mode, the noise generators have some apparent pitch and will track both the keyboard and pitch-bend wheel as you play. If you've played old video games, you'll recognize the timbre of the noise generator, particularly near the low end of the keyboard.

Pan

The Pan slider controls the stereo placement of the oscillators and noise sources. Moving the Pan slider left and right moves the oscillator's output in the corresponding direction in Phosphor's stereo output.

Level

The Level sliders control the loudness of the oscillators and the noise sources. Moving the slider to the right makes the oscillator's tone and the noise louder, moving them to the left makes them quieter. Note that you won't hear the noise source unless you move the Noise slider at least somewhat to the right also.

Velocity Amount (Amt)

The Velocity Amt sliders allow Phosphor to respond to velocity information from your MIDI controller and/or host sequencer. Moving the Velocity Amt slider to the right increases the influence that velocity has on the loudness of the oscillator, i.e. playing your keyboard harder makes the oscillator louder. If you leave the Velocity Amt slider at the far left, the oscillator's loudness will be the same regardless of how vigorously you pound the keyboard.

Pitch Offset

The Pitch Offset slider, present only on the Secondary Oscillator, raises the frequency of the Secondary oscillator relative to that of the Primary oscillator. This slider has a fairly small range; at its rightmost position, it raises the frequency of the Secondary oscillator by only 10Hz. Raising the frequency of the oscillator has either or both of two effects. If both oscillators are heard at the same time, the Pitch Offset slider will introduce a tremolo-like sound as the two oscillators beat against each other. If any cross-modulation is active, the Pitch Offset slider will make the timbre of the carrier more complex and often somewhat discordant.

4. Low-Frequency Oscillators (LFOs)

Phosphor has two low-frequency oscillators (LFOs) that can be used to change, or modulate, several parameters of the Primary and Secondary Oscillators, and the frequencies of the filters associated with the delays.

The LFO controls determine how fast the output of the LFO varies over time. They operate either in units of frequency (Hertz, or cycles per second), or in metrical units. Click the **SYNC** buttons to switch between the two modes. If **SYNC** is off, the LFO's rate can be set from one cycle every 100 seconds (or 0.01 cycles per second, abbreviated 0.01 Hz) to 14 cycles every second (14 Hz).

When **SYNC** is turned on, the rate of the LFO is synchronized to the tempo provided by your host DAW. In this mode the rate control sets the period of the LFO in metrical units. The range of values is $1/32^{nd}$ to 1/1 (a whole measure), with dotted and triplet times available. Triplet values are denoted with a "T" after the beat fraction, and dotted values are denoted with a period. For example, "1/8 ." indicates a cycle length with a dotted eighth note feel. Phosphor will track tempo changes, saving you from having to adjust its LFOs by hand when you change the tempo of your song.

The **WAVESHAPE** slider and **WAVEFORM** buttons work together to control how the LFO's output varies over time. The **WAVEFORM** buttons let you choose one of four waveforms, with sawtooth, pulse, sinusoidal, and randomly determined shapes. The **WAVESHAPE** slider changes the basic waveform in different ways, depending on which waveform is chosen with the **WAVEFORM** buttons. The diagram on the next page illustrates the different modulation signals generated by different settings of the **WAVEFORM** and **WAVESHAPE** controls.

SAW

PULSE

SINE

RANDOM

1%   25%   50%   75%   99%
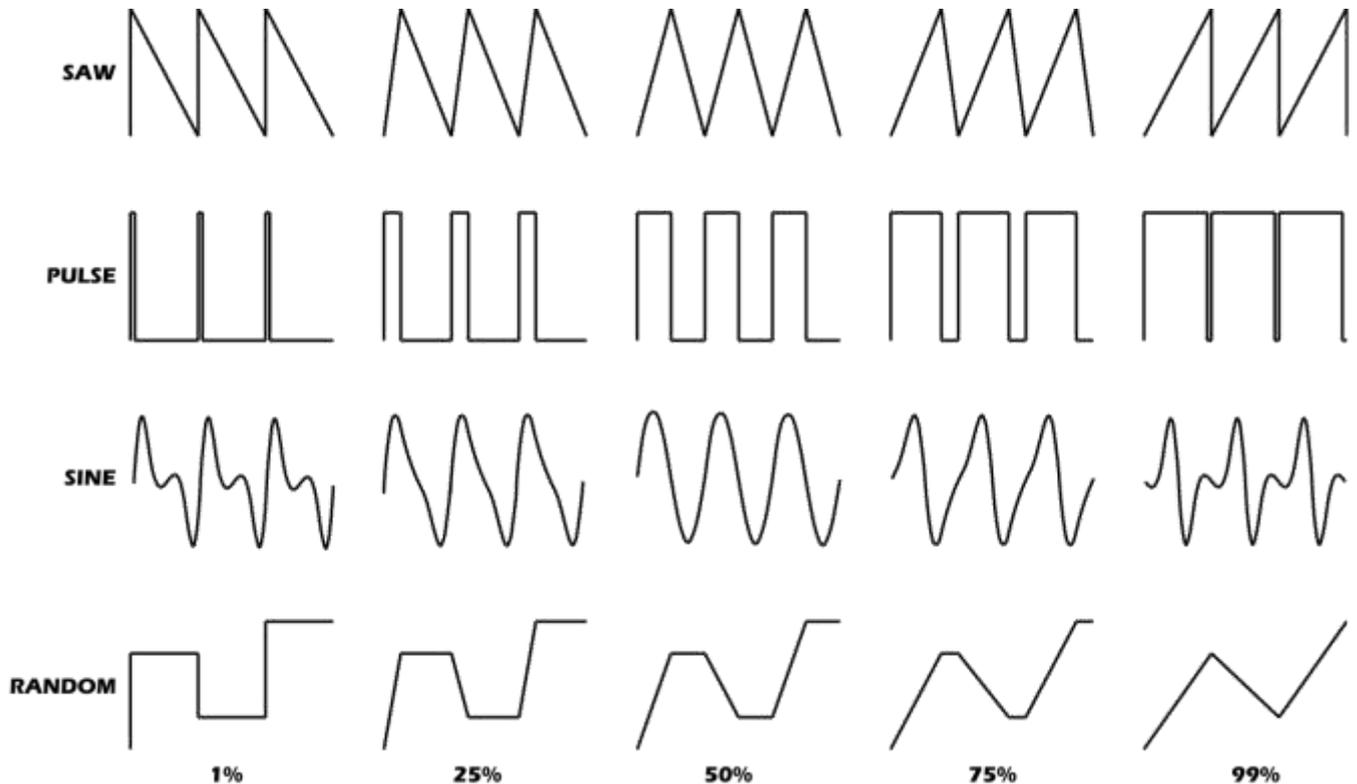
5. Modulation Sliders

The horizontal sliders on the right side of Phosphor's windows are called modulation sliders. They route signals from the LFOs to the Primary and Secondary Oscillators, and to the filters in the delay lines. Each slider can be thought of as controlling a connection between one of the LFOs and one of the parameters of one of the oscillators. The left-hand column of sliders controls connections between LFO One and the oscillators and filters; the sliders on the right control connections between LFO Two and the oscillators and filters.

The sliders are bidirectional. If left at their center position, no signals from the LFOs reach the corresponding parameter in the oscillators and filters. In general, moving a slider to the right of center causes the LFO to

increase the parameter's value and moving it to the left of center causes the LFO to decrease the parameter's value. Simply click and drag on a slider to change its value. If you hold down the ALT key on your keyboard and click the slider, the slider will return to its center position.

More specifically, the sliders under the headings "Mod to Primary Osc" and "Mod to Secondary Osc" have the following functions:

> **PITCH** – moving the **PITCH** slider to the right causes the LFO to raise the pitch of the oscillator, moving it to the left causes it to lower the pitch. Use the **PITCH** slider to introduce subtle vibrato and trill effects, or not-so-subtle pitch slides and jumps.

> **PAN** – moving the **PAN** slider left or right of center causes the LFO to move the output of the oscillator in the corresponding direction in the stereo field. Note that the LFO's influence is added to the position set by the **PAN** slider in the Oscillator panes. Hence if for instance the Oscillator **PAN** slider is set to the far left, and you move the **PAN** modulation slider to the left, you won't hear any change in the oscillator's position because the LFO can't push it any further to the left.

> **AMP** – moving the **AMP** slider to the right of center causes the LFO to make the Oscillator louder, moving it to the left causes the LFO to make the Oscillator quieter. The effect of the LFO is added to the loudness of the oscillator as set by the **LEVEL** slider in the Oscillator pane.

> **NOISE** - moving the **NOISE** slider to the right of center causes the LFO to make the noise generator louder, moving it to the left causes the LFO to make the Oscillator noise generator. The effect of the LFO is added to the loudness of the noise generator as set by the **NOISE** slider in the Oscillator pane.

The sliders under the heading "Mod to Delay Filters" connect the LFOs to the filters following the delay lines. The LFOs can modulate (change) the frequencies of the filters. Moving these sliders to the left of center causes the LFOs to decrease the filter frequencies (as if you were
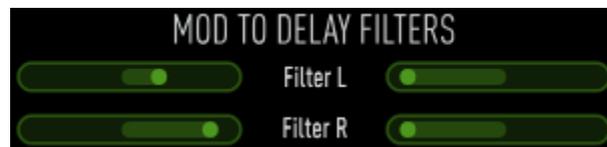
dragging the dot in the filter's control to the left), and moving the sliders to the right causes the LFOs to increase the filter frequencies.

Note that the amount that the LFOs control parameters can be affected by the modulation wheel on your MIDI keyboard. See "Keyboard and Master Controls" below for more information.

6. Delay and Filter Controls

Because we at Audio Damage dearly love delay effects, we've added a stereo delay to Phosphor. The output of each oscillator/noise source passes through its own delay. Each delay has a range of 0 to 1999 msec, or approximately two seconds.

The numeric delay controls operate either in units of time or in metrical units, that is, fractions of a beat. **SYNC** buttons to switch between the two modes. If the **SYNC** mode is active, Phosphor uses the current tempo reported by your host to calculate its delay time. In this mode the delay time control sets the delay length in metrical units. The range of values is $1/32^{nd}$ to 1/1 (a whole measure), with dotted and triplet times available. Triplet values are denoted with a "T" after the beat fraction, and dotted values are denoted with a period. For example, "1/8 ." indicates a delay time with a dotted eighth note feel. Phosphor will track tempo changes, saving you from having to adjust its delay time by hand when you change the tempo of your song.

The **FEEDBACK** sliders control the feedback level, that is, the amount of the output signal which is fed from the output of the delay back into its input. Note that the feedback path goes through the filters.

The **CROSS FEEDBACK** sliders controls a second feedback path. As you move this slider to the right, some of the signal is fed to the input of the other channel. For example, if you move the **R CROSS FEEDBACK** slider, the right channel output signal is fed back into the input of the left channel. This cross-channel feedback can be used to create delay effects that bounce back and forth.

Phosphor has low-pass and high-pass filters which come after the delay lines in the signal chain. These filters can be adjusted to alter the timbre of the delayed signal. For instance, you can use the low-pass filter to create a "darker" sound, or the high-pass filter to create a "thinner" sound.

The filters are controlled in tandem with the graph-like controls. Since the filter controls change the low- and high-pass filters simultaneously the filters act like a band-pass filter with a variable width. Dragging the white circle in the control changes the corner frequencies of both filters. Dragging up and down moves the corner frequencies farther apart and closer together; dragging left and right moves the frequencies in the same direction. As you pull the white dot downwards, the filters move together and allow only a narrow band of frequencies to pass through. You can then move the dot left and right to hear that band move up and down in frequency.

Moving the white dot horizontally changes the filter frequencies in the same direction, moving the frequency pass-band higher and lower

Moving the white dot vertically moves the filter frequencies together and apart, making the frequency pass-band narrower and wider

7. Keyboard and Master Controls

The row of switches and sliders along the bottom of Phosphor's window provide some handy shortcuts for creating new sounds, control Phosphor's response to MIDI keyboards, and setting output levels.

Starting from the left and heading right:

L+R Link

Turning on the L+R Link button cause the controls for the Primary Oscillator and the left delay/filter to affect the corresponding controls for the Secondary Oscillator and the right delay/filter. In other words, if you move a slider on the Primary Oscillator, the corresponding slider for the Secondary Oscillator will move as well. This lets you rapidly adjust parameters both oscillators and delays/filters to the same setting. Note that it doesn't work the other way around: controls for the Secondary Oscillator and right delay/filter do *not* affect their corresponding controls on the left. This lets you set both parameters to the same value with controls on the left, then vary those on the right slightly.

Rand All

Clicking the Rand All button sets most of Phosphor's controls to random positions. Some controls, such as **CROSSMOD**, are not affected because randomizing them tends to not produce useful results. Also, some of the modulation sliders are subjected to only slight amounts of randomization, again with the intent of producing interesting results more often than not. Use the Rand All button to create unexpected starting points for new sounds.

Mod Wheel Destination (Dest)

The **MODWHEEL DEST** pop-up menu controls whether the modulation wheel on your MIDI keyboard affects Phosphor's LFO. It has four positions: **OFF**, **LFO1**, **LFO2**, and **1+2**. If set to **LFO1**, the mod wheel controls how much LFO One affects the parameters it is connected to through the modulation sliders. Pushing the wheel forward increases the LFO's effect. If the Mod Wheel Dest switch is set to **LFO2**, the mod wheel controls LFO Two. If it's set to **1+2**, the mod wheel controls both LFOs. If the switch is set to **OFF**—well, hopefully we don't need to explain this to you.

Poly Mode

The **POLY MODE** pop-up menu determines how Phosphor responds when you play more than one note at a time on your MIDI keyboard. It has three choices:

> Poly – in this mode, Phosphor responds polyphonically, like a piano and most digital synthesizers. Play several keys on your keyboard, and you'll hear several notes.

> Mono – in this mode, Phosphor plays only one note at a time. If you hold down a key on your keyboard, and press another key, Phosphor will not play a new note, but will change its pitch to that of the new key. In this mode, the envelope generators are not restarted when you play additional keys.

Retrig – this is the same as Mono mode, but the envelope generators are retriggered every time you press a key.

Portamento

The Portamento slider creates a sliding effect when the mono or retrig modes are active. If you hold down a key and press another key, Phosphor's pitch will slide to the second note at a rate determined by the sliders. The further you move the slider to the right, the longer it takes Phosphor to slide from one note to the next. The Portamento slider has no effect if Poly mode is active.

8. Output Levels

At the bottom-right corner of Phosphor's window are a couple of controls for the output signal levels:

Delay Mix

The Delay Mix slider controls the relative loudness of Phospor's raw output and the output from the delays and filters. If you set the slider to the far left, you won't hear the delayed/filtered signal at all. If you set it to the far right, you'll hear only the delayed/filtered signal. If you set it in the middle, you'll hear equal amounts of both.

Master Level

The Master Level slider controls Phosphor's overall loudness. Phosphor's signal can vary widely depending on how many partials you use and whether cross-modulation is employed; use this slider to compensate. Moving towards the right makes Phosphor's output louder.

Automation

Most of Phosphor's parameters other than the partials sliders can be automated using your host's automation features. Consult your host's documentation for information on how to use these features.

Presets

Phosphor comes with a selection of presets, organized in the following categories: pads, lead synthesizer, bass, keyboards, and special effects. You can flip through the presets by clicking the arrows to the left of the preset name near the top of Phosphor's window.

You can also click the name itself to invoke a popup menu with several handy features. The menu lists all the factory-installed presets. There is a Save As command for saving your settings in individual files. If you place these files in Phosphor's own folder (located at `C:\ProgramData\Audio Damage\Phosphor\Presets\User` on Windows, `/Library/Application Support/Audio Damage/Phosphor/Presets/User` on OS X), your presets will appear on this menu.

There are also commands for copying the current settings to the system clipboard, and pasting settings from the clipboard. The settings are presented in a plain-text XML format so that you can exchange them online in forums, puzzle your relatives by "accidentally" inserting them in email, etc.

And Finally…

Thanks again for purchasing Phosphor. We make every effort to ensure your satisfaction with our products, and want you to be happy with your purchase. Please write to info@audiodamage.com if you have any questions or comments.